

Friction Pull Plug Welding in Aluminum Alloys

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Abstract:

NASA's Marshall Space Flight Center (MSFC) has recently invested much time and effort into the process development of Friction Pull Plug Welding (FPPW). FPPW, is a welding process similar to Friction Push Plug Welding in that, there is a small rotating part (plug) being spun and simultaneously pulled (forged) into a larger part. These two processes differ, in that push plug welding requires an internal reaction support, while pull plug welding reacts to the load externally. FPPW was originally conceived as a post proof repair technique for External Tank. FPPW was easily selected as the primary process used to close out the termination hole on the Constellation Program's ARES I Upper Stage circumferential Self-Reacting Friction Stir Welds (SR-FSW). The versatility of FPPW allows it to also be used as a repair technique for both SR-FSW and Conventional Friction Stir Welds. To date, all MSFC led development has been concentrated on aluminum alloys (2195, 2219, and 2014). Much work has been done to fully understand and characterize the process's limitations. A heavy emphasis has been spent on plug design, to match the various weldland thicknesses and alloy combinations. This presentation will summarize these development efforts including weld parameter development, process control, parameter sensitivity studies, plug repair techniques, material properties including tensile, fracture and failure analysis.